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ABSTRACT

Designed to provide an overview for educators, this report summarizes experiences to date with applications of communications and computer technology to distance education. Findings relevant to educators concerned with grades K-12 in the six-state region of Arkansas, Louisiana, Mississippi, New Mexico, Oklahoma, and Texas are emphasized. A brief overview of potential distance education technologies covers (1) audio technologies such as audio teleconferencing, audio graphics, freeze-frame video, radio broadcasting, and audio cassettes; (2) computer communications including electronic mail, computer conferencing, and computer-assisted instruction; (3) teletext and videotex; (4) interactive videotape and videodisc; (5) television including Instructional Television Fixed Service and cable systems; and (6) communication satellites. Important factors in evaluating distance learning projects are examined, including student performance; performance of hardware and software; capital, start-up, and operating costs; level of complexity of software development; attitudes of teachers, learners, and project staff; and relationship of project goals to institutional goals. A review of significant projects drawn from the United States, Canada, Great Britain, and developing countries includes examples of applications using each of the technologies reviewed. An analysis of key findings follows each group of project summaries. Final observations are drawn from the project review and distance learning research, and a four-page bibliography is provided. (LMM)

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Distance Learning: A Review for Educators

A Report to the Southwest Educational Development Laboratory

by

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Executive Summary

This report provides an overview for educators of the experience to date with applications of communications and computer technology to education which may be termed "distance education," or from the learners' point of view, "distance learning." Findings relevant to educators concerned with grades K through 12 in the six-state region (Arkansas, Louisiana, Mississippi, New Mexico, Oklahoma, and Texas) are emphasized. Distance learning refers to mediated learning, where the instruction is mediated either by physical distance or by technology (such as a computer program or a videodisc). A brief overview of the technologies that can be used in distance education is provided. These include audio technologies such as audio teleconferencing, audio graphics, freeze-frame video, radio broadcasting, and audio cassettes; computer communications including electronic mail, computer conferencing, and computer-assisted instruction; teletext and videotext; interactive videotape and videodisc; television including Instructional Television Fixed Service and cable systems; and communication satellites.

The report discusses factors that should be taken into consideration in evaluating distance learning projects including student performance; performance of hardware and software; capital, start-up, and operating costs; level of complexity of software development; attitudes of teachers, learners, and project staff; and relationship of project goals to institutional goals.

A review of significant projects follows. Selection criteria include involvement of learners in grades K through 12; incorporation of important

instructional goals; thorough evaluation or detailed assessment; findings important for future planning; and problems or needs which are priorities in the six-state region. The projects are drawn from the United States as well as Canada, Great Britain, and developing countries. They include examples of applications using each of the technologies mentioned above. An analysis of key findings follows each group of project summaries.

The report concludes with observations based on the project review and on research in distance learning. Major observations include:

- Well-motivated students can learn from "big and little" media.
- There is a trend toward using multiple media and lower cost systems.
- Cost considerations should emphasize cost per student.
- Effective management can be crucial to project success.
- Communication and information technologies can ease the burden on overworked teachers.
- Distance learning technologies may be particularly appropriate for adult learners, including teachers.
- Educators must be careful not to "reinvent the wheel" by ignoring lessons learned from earlier experiences with educational technology.
- New technologies are likely to have unanticipated effects on learning and on students which may not be captured by traditional evaluation approaches.

Educators need to consider also the larger issues of the impact these technologies and services will have on education and on our society. Will we use these resources to provide equal educational opportunities to all in the society? And will learners of all ages and backgrounds seize the

opportunity to increase their knowledge or learn new skills? If so, new technologies can overcome many of the barriers faced by disadvantaged students. If not, the knowledge gap will only widen, leaving the disadvantaged even farther behind.

THE CONTEXT

A Glimpse of Distance Learning Today

In a remote Alaskan village, a teacher plays a videocassette that was automatically taped from a satellite feed during the night to help her five high school students learn about the native land claims settlement that has transformed their economic future. In the evening, she will join in an audio conference with other teachers around the state who are taking courses through the LEARN/ALASKA network. In Washington, D.C., the Capital Children's Museum is crowded on a Saturday afternoon with children who are learning from teenagers how to use the microcomputers in the Future Center. In Arkansas, rural high school students learn trigonometry using an interactive videotape package so that mathematics teachers who are in short supply can concentrate on more general topics. In Houston, the same cable system that brings pay television to students' homes brings instructional television into their classrooms. In Los Angeles, children can continue their learning after school by tuning in a teletext program called "Popsicle" on their home TV screens. Across the country, teachers are taking telecourses for college credit by watching programs distributed over their local public or college television stations or over their community cable systems. The program series themselves might have been developed anywhere in the country; they are delivered nationwide by satellite.

These are but a few examples of how children and adults, including teachers, are using new communications technologies for distance learning. This report provides more information on how these technologies are

expanding our notion of learning at a distance, what opportunities and challenges they pose, and what educators need to consider in deciding whether distance education using communications and information technologies can help them meet their major goals.

New Educational Challenges

During the past year, public attention has focussed on problems in the educational system that are well known to educators. There is concern about the "quality of education" which is often described in terms of how well students perform on achievement tests. At the same time, there is a recognition that education is critical to the future potential not only of the students but of the national economy, as the U.S. shifts toward an information- and service-based economy. As a result, parents and educators are now debating what should be taught as well as how it should be taught. And more than ever, learning is becoming a lifelong pursuit.

The advent of a more technological society creates challenges for educators; it also creates opportunities, as new technologies offer many educational promises. While twenty years ago the advent of educational television held center stage, today the computer is touted as an educational savior. However, we learned in the past that the potential of the technology does not guarantee its actualization. But we also need to recognize that there are many new technologies which hold promise for education and that the "communications revolution" is as significant for the future of education as the "computer revolution."

This report attempts to provide an overview for educators of the experience to date with applications of communications and computer technology to education which may be termed "distance education," or from the

learners' point of view, "distance learning." Findings relevant to educators concerned with grades K through 12 in the six-state region (Arkansas, Louisiana, Mississippi, New Mexico, Oklahoma, and Texas) are emphasized.

Developments in Educational Technology

While educational technology has been used in the schools in various forms for the past several decades, recent innovations have made communication and information technologies more appropriate for a wider range of educational tasks. Among these innovations are:

- Information Processing:

Microchip Technology has reduced the size and cost and increased the information storage and manipulation power of computers. Microcomputers can now be used alone or in conjunction with other technologies such as videodiscs for self-paced instruction, and they may also be linked via telecommunications systems to larger computers to access other instructional programs or to retrieve information from libraries and other data bases.

- Telecommunications: In addition to telephone lines and over-the-air broadcasting, there are new means of transmitting information which are being put to use by educators. They include the following.

Coaxial Cable Systems are used for delivery of multiple channels of video throughout a community. New systems often have "institutional loops" which link schools, hospitals, and other facilities within the system with multiple origination points. New cable systems may also be interactive, so that information may be transmitted back to the head-end of the system.

Satellites are used for coverage of the nation or a region. Satellites have the advantage of enabling a signal to be distributed to any location within their beam. Costs of delivering the signal are independent of distance: it costs no more to transmit over 1000 miles than over 100 miles because the signal goes up to the satellite and back to the earth in each case (a distance of over 44,000 miles). Satellite earth stations can be located on the premises of the sites they serve. They can therefore be installed anywhere they are needed without waiting for the terrestrial technology (a coaxial cable or a landline) to get there. This may be particularly important in rural areas which may not benefit from access to cable systems. Satellites may also be used for communicating among several locations in a conferencing mode -- similar to a party line. All users can share the same frequencies without the need for complex switching and balancing of signals. Educators in Alaska and the South Pacific have found this feature important for tutorials for distant students.

Fiber Optics are strands of glass that will convey vast amounts of information. Fiber optics may eventually replace both the telephone wire and the coaxial cable as "electronic highways" into homes, schools, and offices.

- **New Services:** Many new services can enhance the educational value of telecommunications, including the following.

Teleconferencing refers to group communication using audio, video, computers, or some combination of these.

Audio Graphics is a family of technologies that transmit graphic or printed information over a telephone line.

Freeze-Frame (or Slow-Scan Video) transmits still TV pictures over a telephone line.

Compressed Video is a means of sending several video signals through one channel or one transponder on a satellite.

There are also new ways to store and access information:

Videocassette Recorders eliminate the constraint of time, since educational programs can be recorded for later class use or for independent study.

Videodiscs, when coupled with computers, provide a powerful new tool for interactive self-paced instruction and for storage of vast amounts of information.

Floppy Discs hold computer programs or the information created by computer users.

The Educational Context in the Six States

While the technology available to educators has changed dramatically, the educational context has also changed significantly in the past decade in the six-state region.

First, the school-age population has both grown and changed in composition. Between 1970 and 1980, the populations of each of the six states grew faster than the national population growth rate of 11%. The populations of New Mexico and Texas showed the greatest growth, with increases of 28% and 27% respectively. Arkansas' population grew 19%; Oklahoma's, 18%; Louisiana's, 16%; and Mississippi's, 14%.

While the nation as a whole is now overwhelmingly urban, two states in the region are still largely rural. In Mississippi and Arkansas, 53% and 48% of the population resided in rural areas in 1980. Texas was the most

urbanized, with approximately 80% of its population living in urban areas. However, with the exception of Oklahoma and Texas, urban populations increased more rapidly than rural populations in the past decade, so that the majority of all citizens in the region will be living in urban areas by 1990. However, the region is likely to continue to have a higher percentage of rural residents than the nation as a whole. Telecommunications may be particularly important as a means of extending educational opportunities to these students.

One demographic characteristic common to the region is that each state contains substantial minority populations. Mississippi, Louisiana, Arkansas, and Texas have large black populations. New Mexico and Texas have large minority populations of Hispanic origin. In addition, significant American Indian populations are found in New Mexico and Oklahoma.

Another common demographic characteristic is that many states in the region have experienced significant immigration from the northern United States and from Mexico. In New Mexico, for example, only 43.8% of the population have lived in the state all their lives, and fully 20% have lived in the state less than five years. In absolute numbers, Texas has the highest number of immigrants, primarily from Mexico.

Several characteristics of these minority populations are significant. First, they are likely to be poorer than the whites of the region and poorer than their minority counterparts in the nation as a whole. All six states were below the national average in median income in 1974. While nationally the median income of blacks was only 62% of whites' income and the income of Hispanics only 68% of whites' income, in the six states the median incomes were lower both in absolute terms and in comparison with white incomes. In Mississippi and Louisiana, the states with the highest

black populations, blacks earned only 46% of whites' income, or 37% and 25% respectively less than their black counterparts nationwide. In New Mexico and Texas, the states with the largest Hispanic populations, residents of Spanish origin earned as much as Spanish origin residents nationwide, but only 80% and 66% respectively of the income of white residents in their states. (Cullen et al., 1983)

All six states also ranked above the national average in their poverty rates for both incomes and families for 1975. Minorities account for a disproportionate number of individuals and families below the poverty line.

Similarly, in terms of educational achievement, the six states all ranked below the national average in educational achievement in 1976, although there has been continuing improvement. Blacks appear to be the farthest behind in educational attainment, with the percentage of blacks with four years of high school or more ranging from a high of 61.8% in Oklahoma to a low of only 27.4% in Mississippi. In three of the states, Arkansas, Louisiana, and Mississippi, only one in three or fewer blacks had completed at least four years of high school.

The students in the six states who are disadvantaged in terms of their rural location, poverty, and/or linguistic and cultural backgrounds could be major beneficiaries of new information and communications technologies if the latter can be used to help overcome these disadvantages. Computer-based systems can offer the individualized instruction and practice such students need. Telecommunications and video technologies can provide access to supplementary materials to help expand the resources available in rural schools.

The economic environment of the six states is also changing, with a shift to more information- and service-based jobs. Nationally,

approximately 50% of economic activity now involves information in some form -- from the actual production and distribution of information and communications equipment (jobs in publishing, broadcasting, and telecommunications and computer industries) to the many information-processing jobs now associated with virtually any industry. Regional growth in the information sector has paralleled national trends, with several districts in the region now actively recruiting "high technology" industries. Education will be the key to participation in the information economy. New technologies can help to improve and extend educational opportunities for both children and adults in the six-state region.

DISTANCE LEARNING

Defining Terms

The term distance learning originated with correspondence education, when students studied printed materials on their own. It then came to be applied to learning by means of telecommunications. Early applications were courses by radio and later TV; in some regions telephone or radio-telephone was added to allow students to interact with the instructor. Many of these applications developed outside the U.S., perhaps because other countries had devoted fewer resources to education; also, possibly because educators could use the facilities of government-supported broadcasting services.

Today, the term may be used in several ways:

- as above, to indicate learning where the student is physically remote from the instructor; and
- also, where the student learns primarily from materials developed elsewhere, although a teacher or tutor may be available.

The modern approach is more what we could call mediated learning, where the instruction is mediated either by physical distance (as in the examples above) or by technology (a computer program or a videodisc, for example).

Education has been classified into formal and nonformal modes. Formal education refers to curriculum-based instruction, generally as part of a structured educational system, such as a school, college, or university. Formal education may be either in-school or at a distance, for example for chronically ill or handicapped students who cannot learn in the classroom

or for isolated students who have no schools available. Nonformal education refers to learning which is not part of the formal educational system. It may consist of such curriculum-related programs as basic adult literacy programs or general education programs for children or adults which are designed to enhance their general knowledge or convey relevant skills. These modes may be summarized as follows:

formal:

in school: core instruction or supplementary (enrichment)

at a distance: core instruction or supplementary (enrichment)

nonformal:

out of school: curriculum-related or general education

Examples of applications for formal education include:

- microcomputers for classroom use
- videodiscs for self-paced instruction
- audio conferencing for handicapped students
- instructional television.

Examples of applications for nonformal education include:

- educational programs on public TV and cable
- videotext/teletext materials
- home computer educational games.

Technologies Used in Distance Education

A wide variety of communications and information technologies is available to educators concerned with reaching distant students and providing greater opportunities to students in the classroom and in their homes and work places. This section gives a brief overview of the technologies

in use today. Examples of projects using each of these technologies are found in the fourth section.

- Narrowband Technologies: Bandwidth refers to the amount of the frequency band required to transmit a signal. Narrowband technologies require very limited amounts of spectrum such as is available over a telephone line. Technologies which use a limited amount of bandwidth require minor expenditures for telecommunications compared to technologies such as broadcast television which require a thousand times as much bandwidth to transmit the video signal. While we think of telephone lines for voice transmission, other types of information such as text, graphics, still video pictures, and computer data can all be transmitted over telephone lines.

Audio teleconferencing allows distant students to interact with their instructors and with other students. They may use their own telephones or special speakers and microphones designed for groups. Audio conferencing may be done over regular telephone lines, leased lines, satellite circuits, or two-way radio links. Some institutions use "meet me" bridges, equipment that can connect together dozens of lines and balance the signals so that all users can hear and speak normally.

Audio graphics refer to a family of technologies that can be used to transmit graphic material over a telephone line. The "Electronic Blackboard" offered by AT&T transmits images written with chalk on a special board to TV screens at distant sites. Other systems use special wands or tablets.

Freeze-frame or slow scan video is a technology which transmits single frames of video over a telephone line. New frames may be

sent approximately every 30 seconds. Frames may be sent in advance and stored at the distant location for viewing during the audio presentation or transmitted live on a second audio circuit during the instruction.

Radio broadcasting seems to have lost its appeal as a major educational medium in this country because of the ubiquity of television, but radio is still used in the developing world as a low-cost means of reaching schools with poorly trained teachers and adults who never had the opportunity to attend school. Radio is used in the United States as a component for some independent study courses and for general educational programming.

Audio cassettes are an inexpensive and portable means of transmitting information. For courses with limited numbers of students, cassettes are less expensive than radio broadcasting. High speed dubbing machines have reduced the time needed to duplicate tapes, but costs and uncertainties of mail delivery can be a problem.

Electronic mail is a means of transmitting messages between computers using telephone lines. Users have terminals which may access a central computer, often through leased line networks such as Telenet and Tymnet. Messages may be sent to individual "mail boxes" or transmitted in broadcast mode to all users on the system. These systems may also be used for computer conferencing, allowing groups to share views whenever convenient by reading comments and adding their responses to the conference.

Computer-Assisted Instruction refers to a variety of applications of computers in education. Students may use individual

stand-alone microcomputers for tutorials or drill and practice. They may also communicate with other computers via a modem (modulator/demodulator) that connects the computer to the telephone line. An important application of these links between computers is assessing of remote data bases such as library catalogs, on-line reference materials, and special data bases.

- Teletext and Videotext: These technologies are used to transmit print and graphic information for display on a television screen.

Teletext is the transmission of electronic print carried in the vertical blanking interval of a television signal (lines in the TV signal which do not carry picture information) or over a dedicated audio channel such as an FM subcarrier. It is a one-way technology; users can "grab" pages of information as they are transmitted using special decoders, but they cannot send requests for specific information.

Videotext, on the other hand, refers to text transmitted over cable, telephone, or other broadcast channels. A request channel from the user to the distribution center allows the user to request particular frames of information.

- Videotape and Videodisc

Interactive videotape systems combine the memory and information manipulation functions of the computer with the visual capacity of videotape. Visual content is formatted for programmed learning; depending on the student's responses the program branches to different sequences on the tape. The computer provides the interactive element and finds the appropriate sequences on the tape according to student responses.

Videodiscs also combine video with computers. However, video discs have the advantage of immense storage capacity -- over 54,000 addressable frames. Each frame can store a page of information or can be a component of a video sequence. The computer can quickly find any frame on the disc. Thus the videodisc can be a very powerful instructional tool. Combined with a computer, it can be used for complex instructional programs with many branching routines and for realistic simulations.

- Television

Television can be transmitted over the air on VHF or UHF channels or by several other means. Another form of over-the-air service is Instructional Television Fixed Service (ITFS), which uses special frequencies that cannot be received by a TV set without a frequency converter. ITFS is used by institutions that want to reach particular target audiences such as employees at the workplace, schools, or community centers. Television can also be distributed over cable systems which may offer from 12 to 108 channels and which generally reserve channels for educational and community services. Some cable systems are interactive, so that viewers can request particular programs or respond to questions posed during the program.

- Satellites

Satellites are used for national distribution of television programming and for national narrowcasting; that is, reaching specific audiences such as teachers or adult learners. Programming distributed by satellite reaches viewers over the air or through cable systems. Programs may be transmitted by satellite at night

for automatic recording and then played back for students during the day. Satellites are also used for teleconferencing. A common format is a one-way video transmission with two-way audio for questions and discussion. Teleconferencing services often share transponders with other program networks, using different times of day for transmissions.

Many educational communication systems combine several of these technologies: for example, audio conferencing with audio graphics; satellite reception with cable redistribution; electronic mail with computer-assisted instruction. The examples in the fourth section show how educators are harnessing these technologies for a variety of distance learning tasks.

EVALUATION

What Should be Evaluated?

Before discussing individual projects using telecommunications technology, it is important to consider the factors involved with the overall evaluation of such projects. Many approaches have been used to evaluate educational technology and distance learning projects.

Among the factors that should be taken into consideration in project evaluation are the following:

- student performance (achievement, enrollment retention, and other factors);
- performance of hardware and software;
- costs (capital, start-up, operating);
- level of complexity of materials development;
- attitudes of teachers, learners, and project staff;
- relationship of project goals to institutional goals.

Few projects are thoroughly evaluated according to all these criteria. Some of the major issues that should be taken into consideration are outlined below. However, it is important to recognize that traditional approaches may miss what is new and important about these technologies -- individual motivation, creativity, and confidence-building.

Student Performance

Student performance is the traditional criterion used in educational evaluation. Did the students master the content of the course? How do students using the technology compare with students who are not? In

correspondence courses, an important variable to be measured is often enrollment retention. Since correspondence drop-out rates tend to be high, tutorials, interaction, and supporting materials may be evaluated to determine whether they reduce drop-out rates through reinforcement.

A great deal of evidence has been collected on distance learning and educational technology over the years. While each medium appears to have its particular strengths and limitations (see the fourth section), a general conclusion is that students can learn from any medium, "large or small," cheap or costly, if the students are motivated and the content is well presented. (Schramm, 1977)

Of course, the fact that students can learn does not mean that they will. Numerous technological applications have been unsuccessful -- usually not because of the technology itself but because of poor instructional design or insufficient attention paid to teacher and learner needs.

Performance of Hardware and Software

Evaluation must include data on whether the hardware and software met the requirements of the project. Simple data include logs of equipment malfunctions, frequency of repair and replacement, and so on. The important criterion is whether the equipment performed adequately for the task required. A voice-quality telephone line may be perfectly adequate for interaction with distant students, but if the audio levels vary widely or if the connection is frequently lost, the value of the system will be diminished. With freeze-frame video, relatively low resolution may be adequate for some teaching applications but inappropriate for specialized technical or medical training. Transmission of pages of information on videotext systems that are perceived as excessively slow may discourage learners from using the system.

Costs

It is not the purpose of this report to provide a detailed analysis of project or system costs. However, it is important to identify the major cost components that should be considered in assessing distance learning systems.

- Capital Costs: How much must be invested in equipment and space or modifications in space to accommodate the equipment? Advances in micro-electronics have dramatically reduced the cost of many technologies. Microcomputers continue to drop in price and increase in computing power. Video recording and editing equipment has also dropped in price. However, the cost per unit is not the only consideration. How many computers will be required to provide sufficient access for students? If equipment is to be used by learners at home, how should the equipment costs be borne -- through purchase, rental, or inclusion in tuition fees?
- Production Costs: What is required to utilize the technologies? Can appropriate software be purchased or leased, or must it be produced locally? What are the costs of local production, including equipment, personnel, and reallocated staff time? Can these costs be recovered through fees or through selling or leasing software? Can they be spread over several years of utilization?
- Training Costs: How much time and effort will it take for teachers to learn to use the technology? Are special training courses required? Effective utilization must be kept in mind here. An instructor can easily learn how to set up and speak into an audio conferencing system. But learning to communicate effectively with distant learners over the system will require instruction and practice.

- Operating Costs: What resources will be required to keep the system functioning adequately? Will in-house technical staff or outside maintenance contracts be required? How will facilities at remote sites be serviced? Will logistics staff be required to mail tapes, send messages, and keep track of scheduling?
- Telecommunications Costs: An important component of operating costs for communications networks is the telecommunication costs. Here, several factors must be considered. Are there existing facilities that can be shared, such as a local cable system with spare channels or a leased telephone network with unutilized time? Can one service be piggy-backed on another -- such as a teletext channel which transmits information during the vertical blanking interval of a TV picture or an audio channel carried on an audio subcarrier of a TV channel? If telecommunications capacity must be leased, how can costs be reduced? Can narrow bandwidth services such as audio conferencing, audio graphics, or electronic mail be used rather than broad bandwidth services such as motion video? Or can off-peak times of day be used, so that, for example, video programs can be transmitted overnight for recording and viewing the next day? Or can a consortium of users be created to share distribution costs? There are obviously many factors for educators to analyze to determine how to get the most for their telecommunications dollar.
- Complexity of materials development: The issue of software production was alluded to previously in the costs section. Materials development can be an important factor in assessing the appropriateness of distance learning technologies. The range of complexity

is great. At the simplest level, an audio conferencing system requires little preparation to be used for administration. Logistics of scheduling and skill in running meetings are likely to be the only basic considerations. Using the system for tutorials will require additional preparation and practice but relatively little production. At the more complex end of the scale, producing a video program can range from installing remotely controlled cameras in existing classrooms for transmission of some high-level courses to advanced students to full-scale video production with elaborate equipment, professionally developed scripts, production, editing, and support materials. Videodisc production is also complex, requiring careful instructional design, flowcharting, and video production to create the branching sequences.

Attitudes

The attitudes of those associated with the project are also important in overall evaluation. Do the teachers find that the instructional system enhances their effectiveness or distracts them from other tasks? Do they find the equipment simple to operate? If they are being asked to produce instructional materials for distant students in addition to their other tasks, do they feel adequately compensated or overburdened? What are the students' reactions to the technology? Are the hardware and software appropriate for students of different abilities, ages, or locations? Are students enthusiastic or bored, and why? How do the project support staff feel about the project? Does communications technology designed to support administration, for example, help them to do their job, or is it seen as an additional burden? Are technical staff satisfied with the performance of

the equipment and their role in maintaining the system? Do they feel that their expertise is appreciated or underestimated?

Relationship of project goals to institutional goals

Does the project help to achieve goals that are a high priority to the educational institution or is it peripheral to these priorities? Even the best designed and executed project is likely to find little favor with administrators and funding agencies if it is not perceived as addressing an important problem area in the curriculum or target group in the population. Such projects are likely to be regarded as frills that will not be supported beyond the experimental stage, regardless of their success in achieving their own objectives.

A REVIEW OF SIGNIFICANT PROJECTS

The following section reviews projects which are considered significant for one or more of the following attributes:

- they involve learners in grades K through 12;
- they incorporate important instructional goals;
- they include thorough evaluation or detailed assessment;
- they provide findings important for future planning;
- they address problems or needs which are priorities in the six-state region.

It is difficult to find projects that meet all of these criteria. Priority is given to projects for grades K through 12. However, among those included are other projects that stand out as making pioneering uses of the technology, highlighting important findings that could be generalized, or being particularly relevant although designed for other educational levels. In particular, outstanding international projects are included, as are examples of adult education applications that could provide useful insights for in-service teacher training applications.

In this section, the projects are organized according to technology, in general proceeding from simpler technologies (telephone, radio) to more complex and/or expensive technologies (interactive video, satellites) and from narrowband technologies (audiographics, freeze frame video) to wide-band technologies (full motion video).

Narrowband Technologies

- Audio Conferencing

The telephone has been used in education for many years and has regained popularity under the rubric of teleconferencing, meaning interaction among several sites or among several people at two or more sites. Most early audio teaching programs were in higher education.

LEARN/ALASKA:

LEARN/ALASKA refers to a group of telecommunications-based educational projects undertaken by the Alaska Department of Education and the University of Alaska. One of the major components is the use of audio conferencing to link learners statewide. Students may dial into conferencing bridges at the University of Alaska in Anchorage from locations within the state, including more than 100 villages which receive telephone and broadcasting services via satellite. The network is used for student exchanges, school district and Department of Education administration, and tutorials for adult learners taking college or university courses.

The Associate of Arts degree is offered through the University of Alaska via 13 rural education centers. Almost all courses use the audio conferencing network, along with local village teaching assistants to lead discussions and provide input to faculty in determining grades. Two of the classes use tele-courses aired over the LEARN/ALASKA Instructional TV Channel, which is distributed by satellite statewide. (Benning, 1983)

Homebound/Teleteaching:

The public school system in Tucson, Arizona, offers the Homebound/Teleteaching Program for junior and senior high students who are seriously ill or handicapped. Students can listen in to teachers in the classroom and ask questions from home. The Tucson project was modeled on an earlier program in the Los Angeles County schools. (Braucher, 1983)

Teleconference Network of Texas (TNT):

TNT is a four-wire audio network connecting more than 90 health or health-related education facilities to the University of Texas Health Science Center at San Antonio. In its early use of the dedicated telephone network, TNT offered courses for continuing education and professional certification in medical fields, as well as periodical medical and dental updates and two-way seminars. More recently, academic courses have been offered from the University of Texas at Austin, based on existing correspondence courses. Emphasis is given to courses which hospital employees need to complete a Bachelor of Science in Nursing. Evaluation data have indicated a significant demand for such courses, as well as a desire for more visual materials. The addition of microcomputers to the system, now being considered, could provide immediate feedback to the instructor from even larger numbers of students on-line during a session and would permit transmission and manipulation of graphics by the instructor. (Graham, 1983)

Australian School of the Air (SOTA):

Children living on remote stations (ranches) in Australia have for several generations used high frequency two-way radios to communicate with distant instructors. The children study correspondence courses under the guidance of their parents. They have daily contact with the teacher and with other isolated students over the two-way radios, which are also used to contact the Royal Flying Doctor Service for medical emergencies. SOTA is planning a project using Australia's domestic satellite (AUSSAT), which will be launched in late 1985, to provide audio conferencing links to remote students in Queensland as a replacement for the HF network. (AUSSAT, 1983)

• Audio graphics

CYCLOPS:

A new audio graphics system called CYCLOPS allows the teacher and distant students to draw on an ordinary TV screen with a light pen, generating a signal which is converted to digital pulses before transmission through phone lines. Extra visual material can be stored on audiocassettes before sending. The system was used in at least 20 courses in 15 centers in the United Kingdom in 1981 and 1982. It works well technically, but it needs personnel (teacher/tutor, students, telephone operator) with proper training. Costs depend greatly on distance factors and telephone rates. In the British system, students pay travel costs when they come to a campus, but schools pay telephone transmission costs. The CYCLOPS, then, results in lower costs to the student but higher costs to the institution. (Sharples, 1982)

East Oak Cliff (Dallas):

The East Oak Cliff Subdistrict, Dallas ISD, has been making scarce mathematics teachers more accessible with a Gemini Electronic Blackboard system in three schools. The pressure-sensitive surface of the "blackboard" allows the transmission of data over a telephone line, which is decoded at receiving units and then converted to similar patterns on a television screen in another school. The teacher's voice is carried on a second line with a built-in loudspeaker. A math teacher can instruct two large math classes simultaneously. Yvonne Ewell, Associate Superintendent, reports that careful planning is required, but the approach is allowing East Oak Cliff schools to offer both remedial and accelerated math courses more widely. The system is cost-effective, although the Gemini units are expensive, relative to most other audio graphic equipment. Such technology comes under careful scrutiny in the classroom, but its acceptance holds great promise for a quality math program where teachers are scarce. Staff development and inservice training for math teachers using the blackboard are suggested. (Ewell, 1983)

● Freeze-Frame Video

University of Wisconsin Extension (SEEN):

The University of Wisconsin Extension, Statewide Extension Education Network (SEEN) is perhaps the best known audio network at the post secondary level. This service is considered a pioneer in the field and now serves over 35,000 students in 150 sites. The network is used for continuing education, administrative conferencing, and a host of other purposes.

In 1972, SEEN added freeze-frame video to its two-way audio network. A video camera in the originating studio now sends a still picture through the network every 35 seconds. Before the decision to expand from audio graphics to freeze-frame, a survey of users showed that instructors wanted to illustrate with slides, drawings and diagrams from magazines, photographs, and three-dimensional models. Start-up and monthly operating costs would have been impossible with full-motion video, but freeze-frame allowed flexibility at reasonable cost.

Nearly 50 different courses were offered using freeze-frame during 1982-83 to more than 2000 participants, including teachers around the state. Most courses have been non-credit, with credit courses offered in engineering and music. Instructor reaction to the flexibility of the freeze-frame system has been positive. But SEEN staff have found that instructors cannot be expected to invest time in preparing content, developing freeze-frame visuals, and learning how to operate the hardware. Program moderators are now encouraged to help, and a technician provides camera operation. (Baird, 1983)

- Radio Broadcasting

- Wisconsin:

- Radio with telephone "talkback" was an early system in Wisconsin, used for graduate courses for teachers, on-going medical training, and other professional purposes. A limited number of visuals are often sent by mail. Evaluators in Wisconsin (Parker, 1980) indicated that the time period for radio listening in a lecture format should not exceed 12 to 15 minutes

and that lectures should be broken up by student presentations, "buzz groups," or other strategies.

Outside the U.S., many developing countries have turned to radio as an educational medium because production is relatively inexpensive and radios are ubiquitous, especially since the advent of the portable transistor radio.

Nicaragua Radio Mathematics:

One of the most ambitious radio education projects was sponsored by the U.S. Agency for International Development (A.I.D.) to develop techniques to teach arithmetic to primary school children in rural areas where the teachers were poorly trained. The project used elaborate formative evaluation techniques, emphasized local materials (such as string and bottle tops) for students to use during class, and required frequent activity -- students had to make a physical response (clap hands, jump up, say the answer) at least every minute. The 15-minute programs were followed by teacher-led activities using manuals developed by the project. (Friend et al., 1980)

A.I.D. is now sponsoring a follow-up project to develop similar techniques for teaching English as a second language by radio in Kenya.

Radio Schools:

In several parts of the world, radio is used to teach adults basic literacy and other life skills. In Latin America, many such schools were started by religious orders to reach people living in remote regions such as the Andean basin. In Thailand, Pakistan, Mauritius, and many other developing countries adults

are getting access to basic education opportunities via radio.
(Spain et al., 1977)

- Audio Cassettes

The Open University (OU), Great Britain:

For courses with limited numbers of students, audio cassettes are preferred over broadcast of the same material. Over 87% of Open University students have access to audio cassette machines, and it is no more expensive for the Open University to purchase and copy cassettes, including mailing, than to pay for radio transmission for courses with fewer than 500 students. (Bates, 1982)

The trend toward audio cassettes is very evident. In 1981, the OU had 68 courses using 184 audio cassette productions, equivalent to 588 radio programs. Four years earlier there were hardly any OU courses that used material created specifically for audio cassette. The cassettes are favored because instructors feel they have more control over their use and can integrate them more tightly into the course design. Also, the cassettes may be used either as the main medium for content or as supplemental material to comment on texts, visuals, or television. Other uses include serving as resource material, sometimes substituting for field trips.

"Students like audiocassettes," says Bates. "In a majority of OU courses, they rate cassettes as the 'most useful' component after (correspondence) texts. In some courses, they rank as the most useful." Cassettes are convenient, can be played again anytime, and give a feeling of informality.

- Analysis

The impact of audio tutorials on course completion rates is unclear. In one study of tutor-aided correspondence courses, mail and telephone feedback to students were compared, with course completion rates as the criterion. The group with phone feedback had significantly higher completion rates. In another study, tutors were asked to try to improve completion by greatly increasing the telephone tutoring offered in the courses. Results indicated that no amount of phone contact had the effect of improving completion rates. The best predictor of course completion was steadiness of work by the student during the course. (Coldeway, 1982)

A study by Hudson (1983) of correspondence courses offered by the University of the South Pacific using a satellite audio channel for tutorials for distant students in ten Pacific Island countries found no significant difference in completion rates between courses with and without audio tutorials. However, when courses judged to have particularly effective tutorials were isolated, completion rates were significantly higher. This finding indicates that audio tutorials can make a difference if instructors take the time and effort to learn to use the medium effectively.

Bates (1982) insists that if an institution wants to provide fully interactive teaching in a wide range of courses to scattered students, telephone is the only practical way. Bates feels there is enough evidence to support audio conferencing with good tutors in many distance programs, but that it is hard work.

Habit and familiarity are factors that affect technology usage. Administrators, as well as teachers, are not accustomed to telephone teaching. Tutors must learn to modify their skills and to adapt to the medium. More structure and preparation are necessary. Students generally respond well, and Bates thinks telephone teaching will spread, albeit slowly.

Computer Communications

- CONNECT*ED, Arkansas:

CONNECT*ED, a project of the Arkansas State Department of Education, is a state network of electronic information. It links school districts to each other, to the Department, and to other districts in the country via microcomputers, telephones, and a data base where information is stored for retrieval by users at their convenience. Each school district is represented by a site coordinator for training and data collection on costs and usage. CONNECT*ED provides administrators and teachers with current information through the Department's newsletter Online Arkansas, through Education USA Newslines and Information Network, and through the extensive resources of The Source. Online Arkansas includes a calendar of education events and meetings, articles on current education news and issues in Arkansas, and tracking of education legislation during the Arkansas General Assembly.

Results of CONNECT*ED usage indicate that the network improves internal communication within the Department, improves information flow within the districts, and helps to defray the rising costs of the Department's publications.

- Penn Link:

Penn Link is a statewide computer network system for Pennsylvania which serves school districts, regional state department of education offices, libraries, and small colleges and universities. Members pay a \$100 subscription fee plus \$20.75 per on-line hour to join The Source, based in Falls Church, Virginia, and \$90 per year to join Ed-Net, an information system produced by the National School Public Relations Association.

High school students look for jobs and get up-to-the-minute help via Penn Link. Administrators get catalog and price information and do their shopping for the latest hardware and software. Bureau of Press and Communications employees keep abreast of the latest in legislative events that might affect the Pennsylvania Department of Education. The electronic mail users send informal messages.

Linda Walter, of the Bureau of Press and Communications, feels that the biggest problem in setting up the network was not in training the users but in overcoming the relatively high costs of rural service. To avoid paying expensive long distance rates, participating sites have been using TeleNet and TymNet lines. These data communication companies serve as links between local users and mainframe computers in another state. But TeleNet and TymNet do not serve sparsely populated areas. Walter has tried to solve the problem by organizing rural users into one band to demonstrate demand and working with the telephone company to set up toll-free lines for rural networkers to use when calling the nearest TeleNet or TymNet lines. (Hopping, 1983)

- Alaska Department of Education:

A component of the Alaska Department of Education's telecommunications project in support of education is an electronic mail system which now links the State Department of Education in Juneau with other state agencies in Anchorage and Fairbanks, five regional resource centers, and 52 rural and urban school districts. Each site has a computer terminal which can access the central computer to send and receive messages through the telecommunications network. Typically, a school district calls in once a day to check its mailbox for messages and to send its own messages. Messages can be addressed to individual mail boxes or mass mailed to all on the system. The DOE often uses the system in this broadcast mode to notify all districts of administrative matters.

The system eliminates the need to send separate copies of messages to each site and ensures that the "mail" is received the same day. Mail sent through the postal service in Alaska may take weeks to arrive because of infrequent transportation services or bad weather, so that information may often arrive too late to be of use. In 1981, the system handled about 100 messages per day, or about 2000 per month.

In addition to routing administrative matters, the system may be used to request films or special books and materials from the state library, to locate an expert in a particular field through the regional resource centers, or to coordinate visits of athletic teams and field trips with other school districts. (Hudson, 1982)

- Missouri Small Schools Computer Consortium:

In 1982 six small Missouri school districts, the Missouri State Education Agency, and the University of Missouri began exploring the possibilities of how sharing services, particularly the use of computers, could benefit small districts. A cooperative was formed to bring computer literacy to schools too small to purchase services individually. In December 1982 a computer consultant was hired under a joint purchasing agreement. The consultant provides inservice training to teachers, working with the schools on a shared time basis. During the summer of 1983 a mastery management system was developed so that teachers were instructed how to use the computer in terms of subject matter objectives. The eight member institutions contribute an equal amount of money, and the University of Missouri's Office of Rural Development contributes evaluation services and technical assistance. An electronic mail service along with word processing capabilities to teach writing are planned for late 1984, and several additional cooperatives are expected to be formed in the near future.

- Analysis

A recent study commissioned by SEDL (Ploeger, 1983) comprehensively reviewed projects involving the use of computers in instruction. The contents of that study will not be duplicated here. However, other key findings of research on instructional computing are discussed in this section.

A recent study of computer-assisted instruction (CAI), computer-managed instruction (CMI), and computer-based instruction (CBI) by Kulik (1983) considered 51 research studies, after eliminating 250

others because of flaws in research. Referring to all three styles of learning as CAI, Kulik reports that the CAI students clearly score better than those receiving traditional instruction only. If the scores for all 51 studies had been converted to a norm, traditionally-instructed students would have had an average score in the 50th percentile while the CAI group mean score would have been at the 63rd percentile. The studies were spread across a variety of subjects with a concentration in the math and science area. Results also showed that the CAI group had improved retention when tested later and that the learning speed of that group was superior. Bracey (1982) notes that the Kulik study shows greater differences between the two groups than similar studies over the last decade. He hypothesizes that the differences may be accounted for by the improvement now taking place in the technology and in the implementation of the technology.

While Kulik notes that students in secondary school seemed to show greater learning gains from CAI than did college students, a recent set of studies by the Educational Testing Service indicates that elementary students in the CAI group showed greater gain than did the secondary students in the Kulik studies. The ETS research, funded by NIE, covered all subject areas. ETS reports that the study clearly indicates that CAI was found to be an effective learning aid over the long term (at least one year) as well as the short term. (quoted in Kulik, 1983)

The testing also showed that CAI was easily replicated. The ETS studies lasted four years, which would tend to eliminate novelty effects. Greatest gains were in mathematics. Children who used

the CAI program for 10 minutes per day in mathematics scored significantly higher than those who did not; 20 minutes per day usage yielded a gain twice as great. Reading and language arts CAI students had smaller but significant gains which were maintained throughout the study. Drill and practice seemed to be the most effective mode of activity. Cost-effectiveness was also addressed in the ETS studies. CAI costs were found to be within typical compensatory education budgets, but CAI did not prove to be either more or less cost-effective than other methods.

Another study found that when provided to students in addition to normal instruction, computer instruction was found more effective than traditional instruction alone. A study in Mississippi and California, looking at normal instruction supplemented by CAI, found that third grade students gained 2.28 and 2.03 grade levels in computational ability in one year. Another study of arithmetic skills for the middle grades found a gain of 1.3 grade levels for second graders, 1.5 for third, but only .4 for fourth and .5 for fifth. (quoted in Kulik, 1983)

In studies of CAI as a substitute for traditional instruction, nine studies showed CAI subjects with a significant gain over control groups, eight studies showed little or no difference, and three showed mixed results. Studies covered a broad range of grade levels. Some studies indicate that retention from CAI programs is inferior to traditional ones. Two studies of children by ability levels showed that lower-ability level students find CAI drill and practice more effective than do higher-ability children. (Edwards et al., 1975)

Individualized instruction is one of the strengths of computer-aided instruction. Disadvantaged students especially need individual help, whether it be by tutorial, computerized instruction, or some other strategy. The ease of replication gives CAI an advantage over individual tutorials. However, the quality and appropriateness of software are extremely important. For example, Anandam (1981) feels that inadequate software was the reason why the use of PLATO and TICCIT interactive computer systems did not expand in community colleges.

Researchers at New York's Bank Street College have noticed that computer activities seem to elicit more collaboration and peer interaction than other types of classroom tasks. A second area of research involves the effects of the use of word processors on children's writing. Typically, children correct and change their first drafts very little before completion. Some educators feel that the ease of editing and manipulating a manuscript, including computer checking for spelling errors, may make students more interested and proficient in writing. (Chen and Paisley, 1983)

Out-of-school contact with computers may also be important for learning. The Capital Children's Museum in Washington, D.C., provides an informal environment where children can learn about computers. The museum's "Future Center" contains a dozen Atari 800 computers donated by the manufacturer. The teenage staff offers classes in computer literacy and programming for students ranging from three years old to adults. During many sessions, parents accompany their children so that parents and children can play and learn together. Several other cities are planning to create drop-in learning centers similar to the Capital Children's Museum.

Teletext and Videotext

- WETA Teletext Trial:

WETA, the public broadcasting station in Washington, D.C., conducted a teletext trial in 1981 using the Canadian Telidon system, which is preferred by many users because of its high quality graphics. The Alternate Media Center of New York University provided implementation, software, and research support. Teletext facilities were installed in 40 selected households and 10 public sites including the public library, the Capital Children's Museum, the Smithsonian Institution, and the Jewish Community Center. About 120 pages were transmitted daily over four lines of the WETA signal's vertical blanking interval. Content included news, weather, sports, entertainment guides, consumer information, and a job bank. Adolescents in the trial homes, which were generally middle to upper middle class, accessed the entertainment pages most frequently. However, unemployed youth accessed the terminals in the public locations to consult the job bank. At the public locations young people seemed to have no difficulty learning to call up the pages of text, while older people were more apprehensive about trying out the keyboard and more easily discouraged if they made a mistake. (Elton and Carey, 1983)

- KCET Los Angeles:

The teletext service of KCET, Los Angeles, called NOW! uses the French Antiope system. Approximately 60 to 80 pages per day of text are transmitted, including news and sports. The system has recently been used in 100 homes, 6 schools, and 15 other public sites. A children's after-school feature of the service is

"Popsicle," a format which includes activities for youngsters, quizzes, and other "light" information. The in-school feature is called "Think Shop."

Formative research conducted in the six schools participating in the "Think Shop" trial indicates that the series has positive effects on students' motivation and learning. "Think Shop" is used primarily in three ways:

- Teaching current events -- Students read news stories appearing in NOW! and answer questions posed by "Think Shop." Quizzes take advantage of the system's "reveal button." When the button is pressed, answers appear on the screen next to the questions.
- Reinforcing instructional programs -- After viewing a KCET television program, students work on exercises broadcast over "Think Shop."
- Enriching the curriculum -- Stand-alone units have been developed, often at teachers' requests, to address topics such as awareness of the handicapped, space exploration, and computer literacy. (Chen and Paisley, 1983)

Teachers and librarians using the "Popsicle" and "Think Shop" features think that children are motivated to read the teletext screens. The emphasis placed on oral reading and discussion of the teletext vocabulary may also help Hispanic students who are learning English as a second language.

- Channel 2000:

The Channel 2000 videotext experiment in Columbus, Ohio, was a joint venture between the Online Computer Library Center (OCLC),

which developed and operated the system, and Bank One, which offered on-line financial services. Channel 2000 videotext operated in 200 Columbus households from October to December 1980. A keypad and a decoder incorporating an acoustic coupler were provided to connect the telephone line to the home TV set. Information available over the system included:

- academic or reference information: the Video Encyclopedia (Academic American Encyclopedia), containing 32,000 articles, and the Video Catalog, containing 300,000 records of the local public libraries;
- community information;
- learning tools: Early Reader and Math That Counts, materials for preschool and elementary students developed at Ohio State University;
- home banking.

Children most frequently used the Video Encyclopedia, Video Catalog, Early Reader, and Math That Counts. Children could look up encyclopedia articles and order library books for their school assignments. (Chen and Paisley, 1983)

• Ontario Educational Communications Authority (OECA):

Some educators feel that videotext is still a technology in search of a problem. Researchers at the Educational Research Institute of British Columbia note that the British experience and the recent field trials in Canada have been basically business-oriented and have paid little heed to consumers. The Ontario Educational Communications Authority has been recently involved in a field trial of both teletext and videotext using the Telidon

system hardware. The broadcast component (teletext) of the field trial operates during the network hours and thus is available 16 hours a day, seven days a week. Of the 300 pages of text offered, twenty percent is from TV Ontario program listings. The rest is devoted to course offerings at educational institutions. Trial users can also access thousands of pages of information from a remote computer. Schools, libraries, colleges and universities are all part of this trial. (Ruggles et al., 1982)

- Analysis

Videotext and teletext have been evaluated in several short pilot projects, but there has not been sufficient experience to assess their significance for distance learning. The problem is largely the uncertainty of the market for consumer teletext and videotext services. A decade ago, there were numerous proponents of the educational value of cable television; however, without an incentive for urban residents to subscribe to cable services (which arrived in the form of satellite-delivered pay TV), there was not sufficient demand for cable systems to be constructed only for educational purposes.

Similarly, teletext and videotext appear promising means of delivering print and graphics information into the home, not only for entertainment listings and news updates, but also for learning. Yet the commercial services will have to appeal to enough viewers to make the systems commercially viable. While videotext is more versatile because of its interactive characteristics, teletext may diffuse more rapidly because of the low cost of distribution using the vertical blanking interval of existing TV signals.

However, householders will still have to decide that the services provided are worth the cost of leasing or purchasing a teletext decoder.

It should be noted that these technologies do encourage reading, but the amount of information displayed on the screen is very limited. Computer-based systems which provide interactive access to data bases from personal computers or computer terminals using telephone lines may be a more promising means of accessing printed information.

Interactive Videotape and Videodisc:

- Winthrop Rockefeller Model Secondary Program

An Arkansas interactive videotape project, the Winthrop Rockefeller Model Secondary Program, serves primarily high school juniors and seniors. Ten school districts without certified trigonometry teachers began to participate in 1980, followed by physics and chemistry programs. The results from the first trigonometry classes are encouraging. Although no control group could be arranged, students who learned with the interactive tape configuration scored in a range between the 62nd and 99th percentile on the Minnesota examination normed for trigonometry. Price (1983) stresses that practice and homework tend to correlate with achievement using the system and that students do better when on a definite schedule to use the equipment rather than a "work when you want to" approach.

Another interactive video project in Arkansas (Bowen, 1982) matched two groups of college freshmen and sophomores learning

study skills (memory and concentration). Each group took one course by conventional presentation, the other by interactive video. Students reported no strong preference for one mode over the other. Completion times, however, showed major differences. Interactive classes completed the course in approximately one-third the time of the traditional classes.

- University of Nebraska:

Instructional videodiscs were pioneered at the University of Nebraska-Lincoln, in conjunction with KUON-TV and the Nebraska Educational TV Network. The Corporation for Public Broadcasting and other entities aided the early work of the Videodisc Design-Production Group, which has recently become an independent self-supporting organization. An elementary school disc on tumbling, a secondary level Spanish disc, and one for teaching the deaf have recently been produced.

- ABC/NEA SCHOOLDISC:

The American Broadcasting Company and the National Education Association are cooperating to produce instructional videodiscs for the classroom. Although most applications of disc technology have been for industry and higher education, the ABC/NEA SCHOOLDISC is aimed at the fourth, fifth, and sixth grades. The SCHOOLDISC series comprises 20 one-hour videodiscs addressing science, social studies, art, and language arts. Segments are short -- six to ten minutes -- reflecting a growing consensus among teachers that instructional programs should occupy a much shorter time than the previously standard half-hour program.

"Trends in Education" is a segment produced for teacher development, discussing testing and other topics. There is also a current events segment which uses commercial footage from ABC News.

Expansion of the project to include discs for the secondary level is conditional, pending a successful showing in the middle school grades. Costs have been estimated at \$800 for a disc player and \$50 to \$75 for each disc. The entire package contains 20 discs, so that a school might expect to pay about \$2000 for player and discs. (Ruggles et al., 1982)

- Utah State University:

Utah State University has produced and used videodisc material with mentally retarded children, teaching them size, color, and shape with a puppet as "instructor." Utah researchers believe that the computer-controlled videodisc instruction will not only allow self-paced instruction, but will also free the teacher to attend to the students' individual problems. (Ruggles et al., 1982)

- Analysis

Videotape, primarily in the form of videocassettes, has proved its value as an educational tool. Most schools are now equipped with videocassette players for classroom use; recorders can also be used to record educational programs off the air for later use to avoid real time scheduling conflicts.

Interactive applications of videodiscs offer major advantages for interactive applications because of their storage capacity and addressability. Microcomputers can be programmed to find any frame on the disc and to locate different sequences based on student responses. However, development and production requirements of elaborate video programmed learning sequences are complex.

It may be that interactive video technologies are most appropriate for skills training applications such as learning a new job skill, learning to fly, or learning military maneuvers where the visual components are particularly important for task simulation.

Instructional Television

- South Carolina ETV:

The South Carolina ETV network is composed of ten TV transmission stations, six FM radio stations, closed-circuit links, a statewide network of leased cable, ITFS, and microwave. The state produces programs for K through college, including homeviewers.

In the three years prior to 1981, SCETV staged 319 teleconferences, providing specialized training for 74,000 people. Stepp (1980) estimates that CCTV teleconferences provided services that would have cost \$8-9 million, about equal to the three-year leasing costs for the closed circuit system.

In 1961 3,300 students were served by instructional television at a cost of \$194.85 per student. In 1979, reports Stepp, 1,691,669 students got the ITV services at a cost of \$5.83 per student per course. Delivery of a course to a school was \$10 ten years ago. That same delivery costs a little over half that now. During those ten years, a \$2.59 textbook has increased to \$7.38, nearly triple its previous cost. The rise in book costs increases the importance of the drop in price of communications hardware and delivery.

In South Carolina, the ETV system annual costs are 1.2% of the state education budget, including programs and delivery of public TV and radio, continuing education for adults, and technical/

professional courses. The state delivers 176 TV lessons on a typical school day, occupying 80 hours on a multi-channel system.

- Interact (Houston)

The Region IV Education Service Center in Houston, Texas, operates an Instructional Television Fixed Service (ITFS) network covering seven counties. The interactive instructional TV network is designed to serve the educational needs of school districts, business, industry, and government agencies throughout the Houston-Gulf Coast area. The one-way video, two-way audio closed-circuit network broadcasts on four channels, with courses originating from instructional sites at the Service Center and on participating university and college campuses. A talkback system enables students to talk with their instructors and with students at other locations. A courier service is used to deliver course materials and examinations.

Employees of the 55 school districts within the service area can participate in staff development and inservice training workshops being held at the Service Center, as well as certification and degree coursework originating from universities in Houston, without leaving their own districts. InterAct is also intended to equalize educational opportunities for students by enabling small school districts to offer courses not otherwise available. Employees of subscribing companies and agencies may take courses offered on local campuses without leaving their worksites. (InterAct, 1983)

- Texas Association for Graduate Education and Research (TAGER):

The TAGER system connects post-secondary institutions with industry in the Dallas-Fort Worth area. Headquartered at the

University of Texas at Dallas, TAGER distributes courses live from on campus classrooms via an Instructional Television Fixed Service (ITFS) system. (Ruggles et al., 1982) Instructional institutions are linked through a closed-circuit cable and microwave network. Telephone talkback connections allow students to respond to and question instructors. More than 150 courses are available over the network, providing 6,000 hours of instruction. Graduate level courses in engineering and business are the major course offerings to work sites.

Industries pay to join the network and obtain the ITFS reception equipment so that their employees may pursue work-related studies without travelling to campus. Production techniques involve simply transmitting on-campus classes to minimize cost and disruption to faculty.

- Adult Learning Service:

The Public Broadcasting Service (PBS) reaches 88 million or 84% of the households in the United States. Viewers across the country can gain credit at local institutions for courses based on PBS broadcasts through its Adult Learning Service. During the first year of service, an estimated 1.6 million households tuned in to ALS, with an additional million in the second year. In its third operational year over 100,000 students enrolled in courses based on the ALS through nearly 700 colleges and universities.

In the fall of 1984 ALS will launch a national narrowcast service aimed at meeting the needs of colleges and universities which cannot be served through open channel broadcasting. PBS stations will deliver feeds via satellite directly to locations where adults congregate such as libraries, community centers, and work sites.

- New Mexico Telecourses:

A three-year study of state telecommunications for New Mexico began in 1981 at the University of New Mexico. In attempting to expand educational services to varied clients across a state the size of Spain, it became evident that the population of 1.3 million people could not support a single-purpose network for education only. Sanchez and Atkins (1983) report that during the second year of the study, educational telecommunications plans were aligned with a newly-formed association of government agencies and regional industries called the Rio Grande Communications Network.

Currently, telecourse offerings through state colleges and universities are proceeding, including some teacher training and medical programming, with limited data transmission and telephone networking. Sociology telecourse manager Paul Steele notes that while distant students' achievement was equal to that of their on-campus peers in a recent telecourse, only 12 of the 30 students completed all the work and that attrition rates are a continual problem. Steele faults the lack of personal contact with students, which he says results in a feeling of alienation. Although he held office hours by telephone in a recent course, one student made 90% of the calls. (Sanchez, 1983)

Cable Television

- QUBE:

QUBE is a well-known interactive cable television system that was installed by Warner Amex in Columbus, Ohio, in 1977 and was later established in several other U.S. cities. QUBE provides limited

capacity computer terminals and channel selector consoles to a small number of subscribers in each area served. These subscribers can then respond to questions and make requests over any of the channels they select in order to receive entertainment, information, and educational programming. (OTA, 1982) At this writing, programming services have been suspended, suggesting that insufficient numbers of users have subscribed to this relatively expensive service to justify the costs.

- Spartanburg, South Carolina:

An earlier experiment in Spartanburg, South Carolina, used TV cable to examine the educational value of various interactive communication applications. Spartanburg residents felt that adult education and day-care operator training were priority needs for the system, and services were begun after residents were surveyed. (Ruggles, 1982) Television and two-way audio allowed viewers to share experiences as they learned. Evaluation results emphasized the need for carefully matching communication services tailored to users' needs.

- Irvine, California

The Two-Way Cable Television Network in Irvine, California, connects elementary, junior high, and high schools (a total of 24 schools) with the school district offices, two museums, and the City Hall. With 31 mini-studios using simple consumer-quality video cameras, a number of subjects have been taught and the expertise of one teacher has been shared over many classrooms. Students also have been presenters, but decreased funding has shifted emphasis to larger, district-wide basic instruction. English As A

Second Language courses and extension credit courses are offered through the University of California at Irvine.

Since 1974, students have used Irvine's cable channels to share information with peers in other schools. Teachers have used the system to offer a variety of courses to small groups and to participate in interactive teacher training sessions.

Craig Ritter (1982) found that the system encourages children to feel more of a partnership with adults in the education process and to develop more articulate, descriptive communication styles.

- Analysis

We now have more than two decades of experience in using television in education with decidedly mixed results. A 1976 review which summarized the results of 421 comparisons between ITV and traditional instruction found no significant difference in 308 cases. Another review examined 191 comparisons at the college level and reported that 102 of these comparisons favored ITV and 89 favored traditional instruction, although most of the differences were not significant. When attitudes were considered, administrators were more likely to be favorable towards ITV than teachers. At the college level, students seemed to prefer small discussion classes to TV classes and TV classes to large lecture classes. Another review of 862 studies that compared the effectiveness of ITV and traditional instruction concluded that there was strong evidence that ITV, which closely simulates traditional instruction, was as effective as traditional instruction. (reviewed in Anandam, 1981) ITV in distance learning programs seems to have yielded more favorable results. ITV may act as a pacer, motivating

students to keep up with their work. The University of Mid America found that completion rates were markedly improved for courses that included television broadcasts.

The telecourse format appears particularly promising for adult learners. The combination of TV programs for course enrichment and pacing with study materials and seminars at local institutions, as developed by the Open University and practiced in several telecourse programs in the U.S., seems to meet the needs of motivated adult learners.

Experience with cable TV has been less promising. While cable has been used for informal interaction between students at different locations, there appear to have been few successful attempts to use cable for instruction. The local nature of cable forces reliance on local interaction or local production, which may not be of sufficient quality to sustain interest. In addition, exchanges of courses between institutions often wither because each institution has more incentives to offer its own courses than to use prepared programming from other sources. Institutions may make better use of cable systems by sharing the capacity to transmit from their classrooms to learners at other locations such as the work place, home, or community center.

Satellites

- Rocky Mountain States Satellite Technology Demonstration (STD):

One of the earliest efforts to apply satellite technology for in-school education in the U.S. was the Rocky Mountain STD, which transmitted programs using NASA's experimental ATS-6 satellite

during 1974-75. Fifty-six of the total of 68 stations were in rural schools located in Colorado, Idaho, Montana, New Mexico, Utah, Wyoming, Arizona, and Nevada, an area which includes one quarter of the land mass of the U.S. Three terminals in each of the eight project states could receive video and transmit audio. Thirty-two sites had only TV terminals. In addition, 12 public television stations received satellite transmissions for relay to homes in their viewing areas.

STD designed and produced three original program series: "Time Out," a junior high school career education course; "Careers in the Classroom," an in-service training series for classroom teachers; and "Footprints," a program of topical interest to rural communities. A fourth component was the Materials Distribution Service, which consisted of a library and catalog of 400 educational films and tapes selected by the teachers and transmitted by satellite for later reuse.

Most teachers rated the Materials Distribution Service the most successful component of the project. Teachers preferred enrichment programs to mediated instruction that replaced classroom content. College credit and recertification requirements were important motivators for attending the in-service training courses, with more than 500 teachers receiving course credit and 322 receiving recertification credit. (Clearinghouse on Development Communication, 1979) Most teachers felt that the demands of real-time audio response were too restricting in forcing viewing times to fit STD schedules.

While the Rocky Mountain Project was not continued after the ATS-6 experiment, many of the positively rated components have been included in the Appalachian Community Service Network (ACSN).

- Appalachian Community Service Network (ACSN) -- The Learning Channel:

ACSN, or the Learning Channel as it is now called, transmits educational programs for adults using transponder 16 of the RCA SATCOM 3 satellite, which carries most of the popular satellite-distributed cable television services. Content includes learning programs for adults such as career-oriented courses for college credit, leisure time activities, personal skills, and interpersonal relations. (SatGuide, December 1983)

ACSN began as the Appalachian Education Satellite Program (AESP), another experiment on the NASA ATS-6 satellite in 1975. AESP distributed adult education programs via satellite, for retransmission over local cable systems or viewing at colleges and community locations in Appalachia. Content was selected in consultation with educators and community groups in the region, with the primary goal being to provide adult education materials that were not available through local educational institutions. Students used audio links to interact with instructors and attended regular seminar sessions at local centers.

AESP and its successor ACSN collaborated with educational institutions which grant credit for students completing the courses. Another policy continued by ACSN is to identify adult education needs and then to look for the most suitable existing programming, rather than to produce new content specifically to meet these

needs. Continuing education courses for teachers has been a major component of the network programming. The success of the experiment and the commitment of the Appalachian Regional Commission resulted in a decision to establish ACSN as a non-profit, self-supporting educational network distributing its courses on a commercial satellite. (Williams, 1981) Cable systems throughout the United States can now receive the Learning Channel for retransmission via the RCA satellite. Credit for college courses can be arranged through local institutions.

• National University Teleconferencing Network (NUTN) and Campus Conference Network (CCN):

Based at the University of Oklahoma, the National University Teleconferencing Network links university campuses for the provision of teleconferencing services. The original 47 universities which banded together to take advantage of high technology have now expanded to 90 institutions, including several in the six-state region. Other organizations beyond the university community have expressed interest in using the universities' continuing education facilities to receive programs, and there have been initial contacts from organizations interested in commercial use of NUTN's teleconferencing services.

The Campus Conference Network will provide video teleconferencing services for public and private sectors in communities where their 62 affiliated institutions are located. Secondary sites, or associates, will be established in less densely populated areas. The colleges and universities will for the most part own their own earth stations and will share in the revenue from teleconferences.

They may use the facilities for their own programs at times not reserved for CCN transmission. CCN is being organized by Sat Serv, a for-profit subsidiary of the Public Service Satellite Consortium (PSSC).

- Knowledge Network:

The Knowledge Network of the West Communications Authority was created in British Columbia to establish and operate a telecommunications network and to assist educational institutions in the development of programming. The three elements within the system being developed are the educational TV channel, the closed circuit inter-university communication system, and the inter-institutional instructional network. This network uses a cable system of low-powered, line-of-sight TV transmitters for urban areas and satellite distribution for remote areas. Credit and non-credit televised material is offered, as is interactive programming. Teacher training as well as continuing professional education are supported by the interactive sessions. The Knowledge Network now offers a toll-free telephone number to facilitate student interaction. Broadcast hours have broken down as follows:

- 43.5% post-secondary programming;
- 20.0% general education;
- 19.5% grades K through 12;
- 9.0% university use;
- 8.0% government and miscellaneous. (Ruggles et al., 1982)

- Analysis

Satellites appear to offer significant educational potential in the United States, particularly for distributing courses for adult

learning and for teleconferencing. They may also become a means of distributing supplementary materials to schools, especially in rural and isolated areas, following the LEARN/ALASKA model.

Satellites have made possible national narrowcasting; i.e., the possibility of reaching targetted groups across the country. Teachers may benefit from the possibility of taking high quality courses in a range of subjects for local college credit. Satellite-delivered telecourses may become an important component of lifelong learning for adults.

Satellite teleconferencing is probably more appropriate for post secondary applications, such as conferences of specialized faculty on several campuses. Teachers might also use satellite conferencing to share experiences or attend specialized workshops with colleagues from other states. Satellite earth stations owned by public broadcasting stations or universities could be used for this purpose.

It should be noted that several educational users now share satellite transponders, as they do not need 24 hour per day access. Thus, for example, educational programs for taping can be sent overnight by satellite, leaving the daytime hours free for real-time course delivery and teleconferencing.

CONCLUSION

Some Concluding Observations

This report has provided an overview of our experience to date with communications and information technologies for distance education prospects for the future, with particular emphasis on the six-state region. At this time, it is impossible to be conclusive about the role of these technologies in distance learning, but some general observations may be appropriate.

- Learning from Big and Little Media

First, as Schramm stated, students can learn from both big and little media: "Motivated students learn from any medium if it is competently used and adapted to their needs. Within its physical limits, any medium can perform any educational task. Whether a student learns more from one medium than from another is at least as likely to depend on how the medium is used as on what medium is used." (Schramm, 1977)

Students can learn from audio conferencing and from interactive video, from computers and from videocassettes -- and even from books! The choice of medium, or combination of media, will depend on the course content, age and ability levels of the students, and available resources.

- A Greater Diversity in Media

Trends in applying technologies for distance education include:

- an increasing tendency for the same institution to use multiple media to meet the needs of diverse students;

- a decreasing reliance on broadcast media in favor of recorded materials;
- a greater reliance on less expensive, less complex media;
- a wider assortment of options from which to choose (Feasley, 1983).

While these varied technologies hold much promise, they will require careful assessment by educators to determine which technologies to use and how to apply them most effectively.

- Cost Considerations

Measurement of costs depends on many factors. The most costly technologies may not result in high costs per student. For example, a telecourse delivered nationwide by satellite may have a very low cost per student, while an interactive videodisc developed for a specialized course may be much more costly on a per-student basis. Out-of-school projects tend to be highly cost effective if they enroll sufficient numbers of students to share fixed costs. In-school projects which maintain a teacher-student ratio similar to that of conventional schooling do not reduce costs per student as much, since they do not substitute media for labor.

The value of the in-school projects, when they are well conceived and executed, lies in using the media to improve the system sufficiently to justify the additional cost.

- Importance of Management

Effective management is a key to the success of distance learning programs. The planning, implementation, and operation of distance learning programs are complex functions. Well-designed projects that are poorly managed or have inadequate managerial personnel may

be doomed to failure. Careful planning and coordination are required for curriculum planning, lesson design, program production, materials distribution, and student evaluation. A breakdown in any of these functions can undermine the entire project.

- Stretching Educational Resources

Communications and information technologies can ease the burden on teachers. Learning materials can be developed for courses where there is a shortage of specialized teachers, such as science and mathematics. Interactive systems for independent study can free the teachers to spend more time with students who need personal attention. Through communications and information technologies, teacher expertise can be spread where there are shortages, and teacher time can be made available where it is painfully lacking.

- Importance for Adult Learning

Distance learning technologies and services may be particularly appropriate for adult learners, including teachers. The combination of telecommunications and information technologies now makes it possible to deliver instruction to the workplace and the home, where there are growing demands for continuing education and career-oriented instruction.

- Reinventing the Wheel

Many of the lessons learned from earlier experience with educational technology may be applicable in assessing new communication and information technologies. For example, Hechinger (1980) cites the following reasons for early disappointments with educational technology:

- the manufacturers of the hardware proved more sophisticated than the producers of the software;
- producing effective software to answer the varied needs of the classroom called for writing and editing skills which were in short supply;
- producers of hardware made their products incompatible with software produced by competitors, thus raising the cost to the consumer;
- educators often approached the technology with doubts or even open hostility, fearing that the machine might be used to replace the teacher, even though the intention of the producers was primarily to make teachers more effective;
- the equipment often required too much technological sophistication and costly maintenance.

Educators should keep these lessons from the past in mind when assessing new technologies.

- Unanticipated Effects

New communication and information technologies are likely to have unanticipated effects on learning and on students which may not be captured by traditional evaluation approaches. Computer use by children may enhance their problem solving ability and creative thinking, as well as teaching program content. Ability to search through interactive data bases may stimulate intellectual curiosity. Opportunities to learn and practice individually may improve students' motivation and self esteem. We must be open to new applications of the technologies and imaginative research strategies that will fully explore the potential of the technologies.

Future Implications of the New Technologies

The discussion of evaluation in the third section lists questions that should be addressed to determine the appropriateness and effectiveness of various technologies and services for distance learning. However, educators need to consider also the larger issues of what impact these technologies and services will have on education and on our society.

Nearly 40 years ago, Lasswell posed the classic question on the effects of mass media: "Who says what to whom through which channel and with what effects?" (Lasswell, 1948) Chen and Paisley modify this paradigm to consider the impact of computers on children. "Who learns what from which computer-based system and with what effects on other learning and behavior?" (Chen and Paisley, 1983) We might want to apply this paradigm to generate a series of questions for future evaluation, for example:

- Which groups in the society have access to distance learning services?
- What are the barriers to access and how can they be overcome?
- What are the individual characteristics of those who make greater or lesser use of distance learning resources?
- Which content resources are used? By which groups of users? What levels of learning are attained?
- Is there differential use of communication and information technologies by group or individual characteristics?
- What are the secondary or unintended learning outcomes? What were the surprises?

Answers to these questions will help us to understand the impact of these technologies and services not only on students but on the society as a whole. We now have the capability to provide learning opportunities to

all citizens, children or adults, in school, at work, or at home, in cities and rural areas. Will we use these resources to provide equal educational opportunities to all in the society? And will learners of all ages and backgrounds seize the opportunity to increase their knowledge or learn new skills? If so, new communication and information technologies will contribute significantly not only to improving the quality and accessibility of education in the United States, but also to overcoming the barriers of geography, wealth, culture, and race. If not, the knowledge gaps within our society may increase, creating an information underclass that will not be able to participate fully in an increasingly information-oriented society.

Bibliography

- Anandam, Kamala. "Evaluating the Used Technology Education." In Technology and Education: Policy, Implementation, Evaluation, Proceedings of the National Conference on Technology and Education. Institute for Educational Leadership, Washington, D.C. 1981.
- "AUSSAT: Australia's National Satellite System" Prospectus. Sydney: AUSSAT Pty. Ltd., 1983.
- Baird, Marcia. "Teleconferencing in Wisconsin: Adding Freeze-Frame Highlights." In Teleconferencing and Interactive Media, Parker, Lorne and Christine Olgren, eds. Madison: University of Wisconsin-Extension, 1980.
- Bates, Anthony. "Trends in the Use of Audio-Visual Equipment in Distance Education Systems." In Learning at a Distance: A World Perspective. Daniel, John, Martha Stroud, and John Thompson, eds. Edmonton: Athabasca University/International Council for Correspondence Education, 1982.
- Benning, Marjorie. "Bridging the Last Frontier: The LEARN/ALASKA Instructional Telecommunications Network." In Teleconferencing and Electronic Communications II. Parker, Lorne and Christine Olgren, eds. Madison: University of Wisconsin-Extension, 1983.
- Block, Clifford. "Matching Educational Needs with Available Technology: What is Happening in the Rest of the World." In Technology and Education: Policy, Implementation, Evaluation. Proceedings of the National Conference on Technology and Education. Institute for Educational Leadership, Washington, D.C., 1981.
- Bowen, Linda. "CBI: It Teaches." T.H.E. Journal, September 1982.
- Bracey, Gerald. "Computers in Education: What the Research Says." Electronic Learning, November/December 1982.
- Braucher, Bettye Hill. "Teleteaching: Interaction on a Shoestring." In Teleconferencing and Electronic Communications II. Parker, Lorne and Christine Olgren, eds. Madison: University of Wisconsin-Extension, 1983.
- Challenor, Herschelle, et al. "International Tele-Education: An Imperative for Meeting Educational Needs." Proceedings of the Pacific Telecommunications Conference. Honolulu: January 1984.
- Chen, Milton, and William Paisley. "Children and the New Computer Technologies: Research Implications of the Second Electronic Era," Stanford: Institute for Communication Research, 1983.

- Clearing House on Development Communication. Project Profiles. Washington, D.C.: Academy for Educational Development, 1979.
- Coldeway, Dan. "Recent Research in Distance Learning." In Learning at a Distance, A World Perspective. Daniel, John, Martha Stroud, and John Thompson, eds. Edmonton: Athabasca University/International Council for Correspondence Education, 1982.
- Cullen, R., Fredlund, E. and Teresa A. Sullivan. "Population Statistics for Educational Needs in the Six-State Region: A Descriptive Analysis," Austin: Southwest Educational Development Laboratory, 1982.
- Educational Telecommunications for Alaska. Juneau: Alaska Department of Education, 1982.
- Edwards, Judith, et al. "CAI: How Effective Is It?" Educational Leadership, November 1975.
- Elton, Martin. "The Practice of Teleconferencing." In Telecommunications in the United States: Trends and Policies. Dedham, MA: Artech House, 1981.
- Elton, Martin and John Carey. "Computerizing Information: Consumer Reactions to Teletext." Journal of Communication, Winter 1983.
- Estes, Nolan. "Technology in Public School Systems." Unpublished paper, 1983.
- Ewell, Yvonne. "Multiplying the Math Teacher: An Electronic Aid to Help Meet the Shortage." Educational Technology, February 1983.
- Feasley, Charles E. Serving Learners at a Distance: A Guide to Program Practices. Washington: Association for the Study of Higher Education, 1983.
- Fiske, Edward B. "New Priority: Technological Literacy." New York Times, April 24, 1983, Section 12, p. 1.
- Fiske, Edward B., "Study Asserts Quality of Schools Presents Economic Threat to U.S." New York Times, May 5, 1983, p. 1.
- Friend, Jamesine, Barbara Searle, and Patrick Suppes. Radio Mathematics in Nicaragua. Stanford: Institute for Mathematical Studies in the Social Sciences, 1980.
- Futagami, S. et al. The Educational Use of Mass Media. Staff Working Paper. Washington: The World Bank, 1981.
- Gibbons, J.F., W.R. Kinchloe, and K.S. Down. "Tutored Videotape Instruction: A New Use of Electronics in Education." Science, March 1977.
- Graham, Lynn. "Teleconference Network of Texas: Hotline to Continuing Education." Pamphlet. San Antonio: University of Texas Health Science Center, 1983.

- Hechinger, Fred M. "Forty Years of Educational Technology." In The Communications Revolution and the Education of Americans. New Rochelle, NY: Change Magazine Press, 1980.
- Hopping, Lorraine. "Pennsylvania: A Statewide Networking System." Electronic Learning, May 1983.
- Hudson, Heather E. "How Close They Sound: Applications of Telecommunications for Education and Public Participation in Alaska." Systems, Objectives, Solutions. November 1982.
- Hudson, Heather E. "Teleconferencing as a Tool for Development." In Teleconferencing and Electronic Communications. Parker, Lorne and Christine Olgren, eds. Madison: University of Wisconsin-Extension, 1982.
- Hudson, Heather E. "Satellite Communications and Rural Development: A Synthesis of Recent Research." Proceedings of the Fourth World Telecommunication Forum. Geneva: International Telecommunications Union, 1983.
- Hudson, Heather E. and Lynn York. "Information and the Economy: Policy Issues for Educators." Austin: Southwest Educational Development Laboratory, June 1983.
- Hurly, Paul, Denis Hynka, and Janet Hurly. "Videotex -- An Interactive Tool for Education and Training." In Teleconferencing and Electronic Communications I. Parker, Lorne and Christine Olgren, eds. Madison: University of Wisconsin-Extension, 1982.
- "InterAct Instructional Television Network." Information sheet published by Region IV Education Service Center, Houston, 1983.
- Kaye, A. and G. Rumble. Distance Teaching for Higher and Adult Education. London: Croom Helm in association with Open University Press, 1981.
- Kruh, Jan. "Student Evaluation of Instructional Teleconferencing." In Teleconferencing and Electronic Communications II. Parker, Lorne and Christine Olgren, eds. Madison: University of Wisconsin - Extension, 1983.
- Kulik, James, et al. "Effects of Computer-based Teaching on Secondary Students." Journal of Educational Psychology, February 1983.
- Marsh, George and Barrie Jo Price. "Interactive Video: The Dreaded Change." T.H.E. Journal, May 1983.
- McAnany, Emile et al. "Distance Education: Evaluating New Approaches in Education in Developing Countries." Evaluation in Education, Vol. 6, 1983.

- Miller, Phillip. "Participatory Television: Education and Interactive Cable TV." In Teleconferencing and Electronic Communications I. Madison: University of Wisconsin-Extension, 1982.
- Munshi, Kiki S. Telecourses: Reflections '80. Washington: The Corporation for Public Broadcasting, 1980.
- National Commission on Excellence in Education. "A Nation at Risk: The Imperative for Educational Reform." Education Week. April 27, 1983.
- Office of Technology Assessment. Information Technology and Its Impact on American Education. Washington: U.S. Government Printing Office, 1982.
- Paisley, William. "Computerized Information: Lessons of a Videotext Trial." Journal of Communication, Winter 1983.
- Parker, Lorne. "More Than Meets the Eye: Effectiveness of Audio and Two-way Audio for Distance Learning." Madison: University of Wisconsin-Extension, 1980.
- Perraton, Hillary. "Distance Teaching North and South." In Learning at a Distance: A World Perspective. Daniel, John, Martha Stroud, and John Thompson, eds. Edmonton: Athabasca University/International Council for Correspondence Education, 1982.
- Ploeger, Floyd. "The Effectiveness of Microcomputers in Education." Austin: Southwest Educational Development Laboratory, 1983.
- Radio for Education and Development: Case Studies, Vol. II. Spain, Peter, Dean Jamison, and Emile McNany, eds. Washington: The World Bank, 1977.
- Ritter, Craig. "Two-way Cable TV: Connecting a Community's Educational Resources." Electronic Learning, October 1982.
- Ruggles, Robin, et al. Learning at a Distance and the New Technology. Vancouver: Educational Research Institute of British Columbia, 1982.
- "Satellite Information." SAT Guide, December 1983.
- Sanchez, Alex and Amy Atkins. "Executive Summary: Telecommunications Network for Education in New Mexico." Project Report, 1983.
- Schramm, Wilbur. Big Media, Little Media. Beverly Hills: Sage, 1977.
- Sharples, M. "An Evaluation of the CYCLOPS Telewriting System for Distance Tutoring of Open University Students." In Teleconferencing and electronic Communications I. Madison: University of Wisconsin-Extension, 1980.
- Stapp, Thomas. "The South Carolina Telecommunications System." In Technology and Education: Policy, Implementation, Evaluation, Proceedings of the National Conference on Technology and Education. Washington, D.C.: Institute for Educational Leadership, 1981.

Williams, Nofflet. "Appalachian Community Service Network: Interactive Distance Education." In Teleconferencing and Interactive Media. Parker, Lorne and Christine Olgren, eds. Madison: University of Wisconsin-Extension, 1980.

Telephone Interviews

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